case study

Impact of Greenroof Technology in Pune

Introduction

Pune, often called the "Oxford of the East," has long been a hub for education, drawing students from across India and abroad. Renowned institutions like the University of Pune, Symbiosis International, and Fergusson College have positioned the city as a center of academic excellence. In addition to its thriving education sector, Pune is a burgeoning IT hub, with areas like Hinjewadi and Magarpatta City hosting major multinational companies. Complementing its academic and technological growth, the city's industrial belt in Pimpri-Chinchwad has attracted numerous manufacturing units, ranging from automotive to engineering. This rapid urbanization and population influx have transformed Pune into a bustling metropolis, but they have also brought significant environmental challenges.

As Pune grows, the impacts of climate change have become increasingly evident. Rising temperatures, irregular monsoon patterns, and frequent urban flooding are among the challenges the city faces. The urban heat island (UHI) effect is particularly pronounced, with concrete structures and asphalt replacing natural landscapes, leading to higher temperatures in densely populated areas. Moreover, the strain on water resources, increased energy consumption, and reduced green cover exacerbate the city's vulnerability to climate change. These changes threaten the environment and pose risks to public health, infrastructure, and the overall quality of life for its residents.

Amid these challenges, green roof technology (GRT) is emerging as an innovative and sustainable solution. By transforming barren rooftops into vibrant green spaces, GRT addresses multiple urban issues such as the UHI effect, air quality, and stormwater management. It offers a practical way to integrate nature into the built environment, making cities more resilient to climate change. In Pune, the adoption of green roofs is gaining momentum, with residential, commercial, and public sectors recognizing their potential to create a more sustainable and liveable urban landscape.

Therefore, this case study on the impact of green roof technology in Pune is crucial for understanding how this innovative solution can help address the city's environmental challenges. By examining the benefits of green roofs, this study offers valuable insights into how this technology can improve urban sustainability, reduce the urban heat island effect, enhance air quality, and contribute to climate resilience in Pune. The findings will serve as a guide for stakeholders in shaping sustainable urban development strategies for the city's future.

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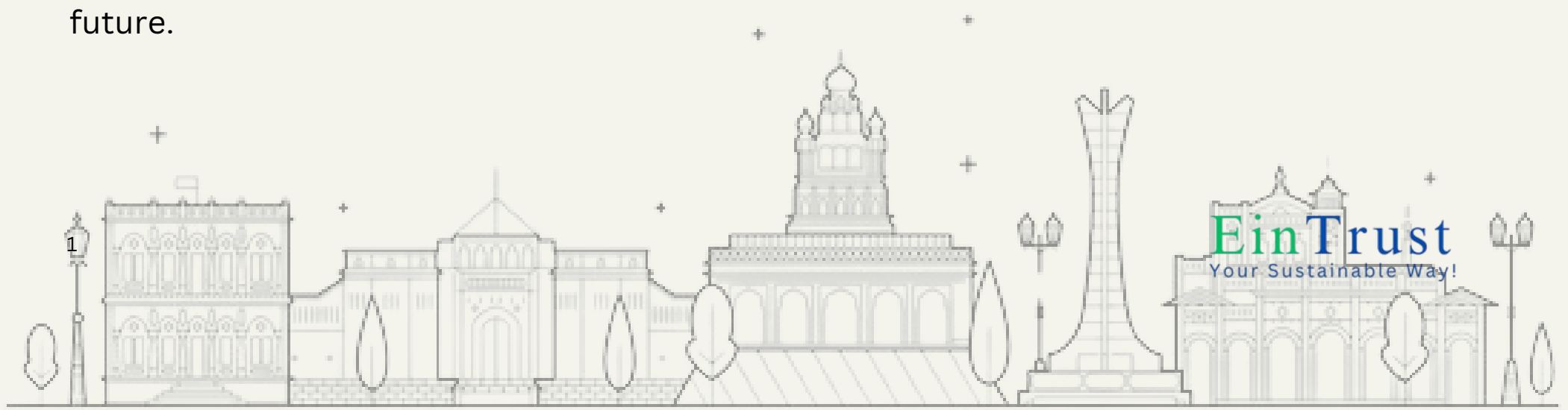
Background

City Profile of Pune

Pune is one of the fastest-growing cities in the Asia-Pacific region, a trend that has been consistent for several decades. Between 1991 and 2001, the city grew by 40%, with its population increasing from 1.6 million to 2.5 million. Over the past 40 years, the decadal growth rate has consistently been at least 40%, and if this trend continues, Pune's population is expected to reach 5.6 million by 2031.

Along with rapid urbanization, the Pune Municipal Corporation has found that approximately 40% of the city's population was living in slums in 2011, highlighting the challenges of providing adequate housing and infrastructure for the growing population. This rapid growth has contributed to the city's rising demand for energy, which has increased substantially over the years.
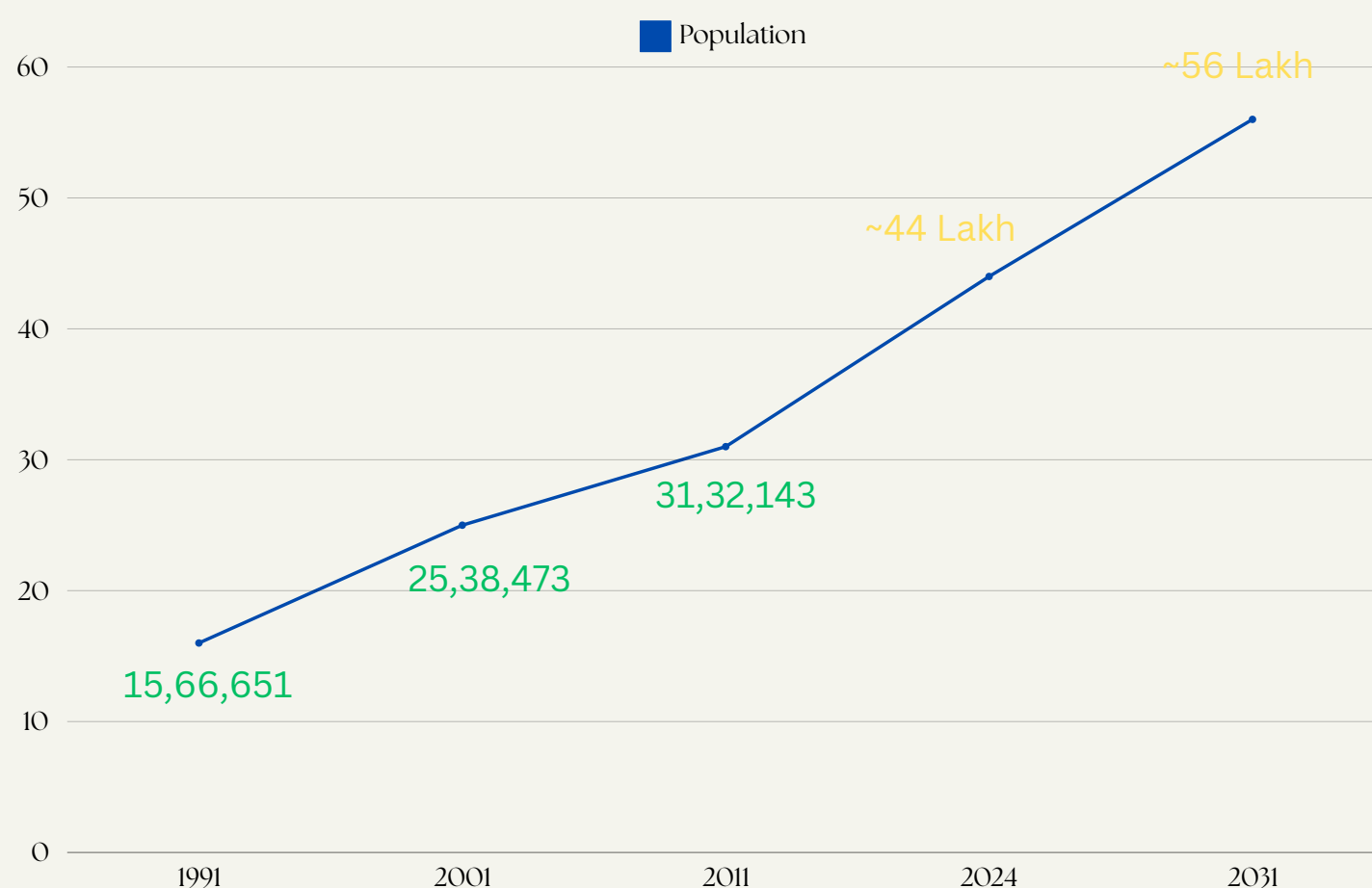
In 2020-21, Pune's total energy consumption was recorded at 4,463.59 million units (MU), rising to 4,982.89 MU in 2021-22. The residential sector accounted for the largest portion of energy consumption at 2,144.22 MU, followed by the industrial sector at 1,330.29 MU, and the commercial sector at 951.53 MU.

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The city's urbanization has also led to increased levels of pollution. According to a 2019-2020 emission inventory by IITM, PM10 emissions were 86.60 Gg/year and PM2.5 emissions were 46.40 Gg/year. The transport sector was responsible for 73% of Nitrogen Oxide (NOx) emissions, totaling 222.01 Gg/year, while the industrial sector accounted for 82% of Sulfur Dioxide (SO2) emissions, totaling 191.57 Gg/year.

The temperature in Pune has risen significantly, with the highest recorded temperature reaching 41.8°C in 2022, compared to 39.6°C in 2021. This increase in temperature is a sign of the intensifying Urban Heat Island (UHI) effect, leading to higher energy consumption for cooling, worsened air quality, and increased health risks.

Given these challenges, the adoption of green roofs in Pune could play a pivotal role in addressing the UHI effect, reducing energy demand, improving air quality, and enhancing the overall sustainability of the city.

What is Greenroof Technology?

A green roof, sometimes called a living roof or rooftop garden, is a creative way to bring nature back to urban spaces by growing plants on the rooftops of buildings. This concept helps counteract some of the environmental harm caused by city development, turning unused rooftop space into vibrant green areas.

The plants on a green roof can thrive as long as the building itself stands, helping to reduce the building's overall environmental impact. What's even more exciting is that many of the materials used to build these green roofs can come from recycled urban waste, making this solution both sustainable and eco-friendly.

There are three main types of green roofs, as defined by the German FLL Guideline for Green Roofs in 1982:
1. **Extensive Green Roofs:** Lightweight, low-maintenance roofs with drought-resistant plants like sedums.
2. **Semi-Intensive Green Roofs:** Medium-weight roofs supporting a variety of plants, such as grasses and shrubs, with moderate maintenance.
3. **Intensive Green Roofs:** Heavier roofs that can support trees, lawns, and gardens, requiring more maintenance and structural support.

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EXTENSIVE GREEN ROOF

SEMI-INTENSIVE GREEN ROOF

INTENSIVE GREEN ROOF

SOLAR GARDEN ROOF

BLUE GREEN ROOF

Green roofs have advanced with innovations, including:

1. **Solar Garden Roofs (BioSolar)**: These roofs combine plants with solar panels, boosting energy efficiency.
2. **Blue-Green Roofs:** These integrate water management systems, allowing rainwater to be stored and reused.

Green roofs represent a sustainable approach to urban development, reducing environmental impact while enhancing biodiversity, air quality, and thermal insulation.

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Implementing Green Roof Technology in Pune

Implementing green roof technology within Pune requires a focused and practical approach, ensuring that the right buildings and areas are selected to make the most of available space.

Key Areas for Green Roof Projects:

- **Residential Areas:** High-density neighborhoods like Hadapsar, Aundh, and Kothrud have a mix of apartment buildings and individual houses. While rooftops in these areas often have limited space due to things like water tanks and air conditioners, smart planning can make green roofs a reality by optimizing available space.
- **Commercial Areas:** Busy commercial zones such as Shivajinagar, Koregaon Park, and MG Road, which have office buildings and shopping malls, often feature large, flat rooftops. These spaces are perfect for green roofs, as they can accommodate more greenery and require fewer adjustments to infrastructure.
- **Public & Institutional Buildings:** Buildings like Pune University and municipal offices often have larger rooftops that could be transformed into green spaces. These spaces not only benefit the environment but can also serve as places for relaxation and education.

Rooftop Space & Considerations:

The success of a green roof project depends on the available rooftop space. Flat or slightly sloped roofs are ideal, as they provide more area for planting. However, the weight of the green roof system—soil, plants, and water retention materials—needs to be considered. Before installation, it's important to check whether the building can support this additional load. Rooftops also often have features like water tanks or AC units that take up space. In such cases, it's necessary to work around these structures, possibly by relocating or building the green roof around them.

Maximizing Rooftop Potential:

To make the most of available rooftop space, we may need to clear clutter or strengthen the structure to hold the weight of the green roof. In crowded spaces, modular green roof systems can be used to create green areas around existing installations. Green roofs can help cool down the temperature, improve air quality, and manage rainwater, which is especially important for urban areas facing the heat island effect.

By focusing on the right areas and ensuring buildings can support green roofs, Pune can take a significant step toward becoming a more sustainable, energy-efficient city. Prioritizing residential, commercial, and public buildings with the potential for green roofs will help create a greener and healthier urban environment.

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Impact

Environmental

- Reduces Urban Heat
- Cleans Air
- Manages Rainwater
- Supports Biodiversity
- Captures Carbon
- High Resource Demand
- Risk of Non-Native Plants

Economical

- Cut Energy Costs
- Increase Roof lifespan
- Generate Jobs
- Adds Property Value
- Saves on Drainage Cost
- Extra Structural Work and its relative costs

Social

- City Beautification
- Stress Reduction
- Create Community Spaces
- Better Well-being

Green roofs bring a mix of positive and negative impacts across environmental, economic, and social dimensions. Balancing these benefits with potential challenges is crucial for sustainable green roof adoption.

Challenges

1. **High Costs:** Installation and upkeep of green roofs can be expensive, making them less accessible.
2. **Structural Limitations:** Older buildings might need upgrades to handle the weight of a green roof.
3. **Leakage Risk:** Poor waterproofing can cause leaks, especially during Pune's heavy monsoons.
4. **Coordination Issues:** Lack of teamwork among city departments can slow green roof projects.
5. **Climate Adaptation:** Finding plants that can survive Pune's tropical weather is a challenge.
6. **Low Awareness:** Public understanding of green roof benefits is limited, affecting adoption rates.
7. **Infrastructure Compatibility:** Integrating green roofs with existing drainage and energy systems can be tricky.
8. **Aesthetic Over Functionality:** Some designs focus more on looks than long-term benefits.

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Green roof Initiative in India

Ahmedabad

- **Pilot Project:** In 2020, the Ahmedabad Municipal Corporation (AMC) installed green roofs on government buildings to study their effects on urban heat and energy consumption.
- **Results:** Research by CEPT University highlighted a 2°C to 4°C reduction in indoor temperatures and a 20% decrease in cooling energy costs during peak summer months.
- **Potential Impact**: Scaling green roofs across the city could reduce Ahmedabad's average temperature by 0.5°C to 1°C, helping to combat the Urban Heat Island (UHI) effect.

Telangana State

- **Policy Initiative:** The Telangana Municipal Administration and Urban Development Department introduced a policy to encourage green rooftops for residential and commercial buildings in Hyderabad.
- **Energy Savings:** The Telangana State Renewable Energy Development Corporation (TSREDCO) reported that green roofs combined with solar panels enhanced energy efficiency by up to 15%, supporting the state's sustainable energy targets.
- **Potential:** By implementation of cool roofs on 300 sq.km of roof area over a five-year period could potentially result in an annual electricity savings of approximately 600 million units (kWh) for the state of Telangana and could lead to a one-time carbon offset of 30 million tonnes of CO_2 emissions.
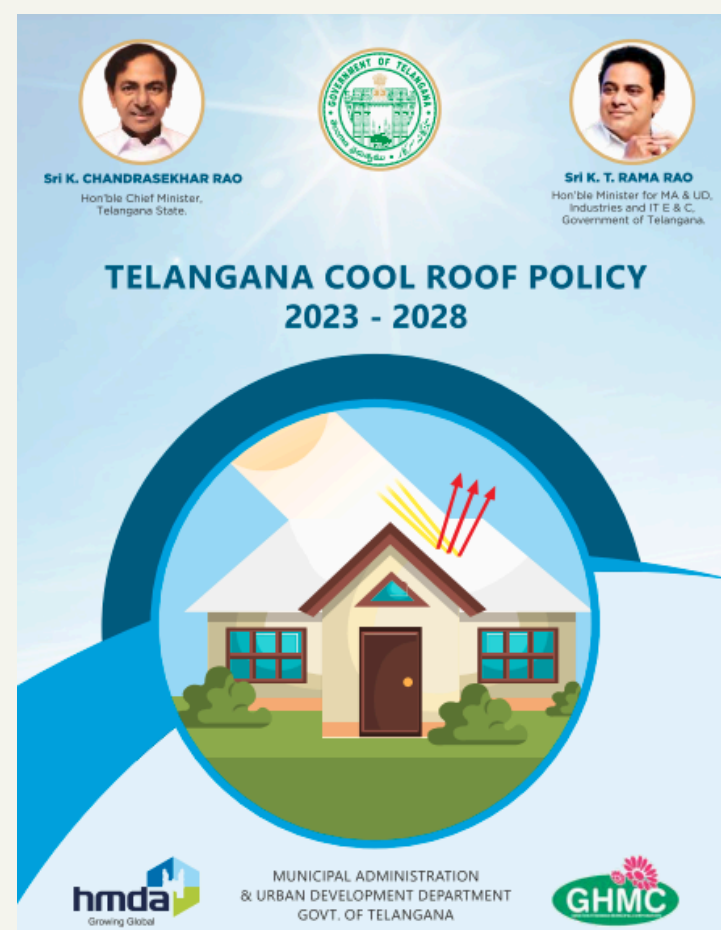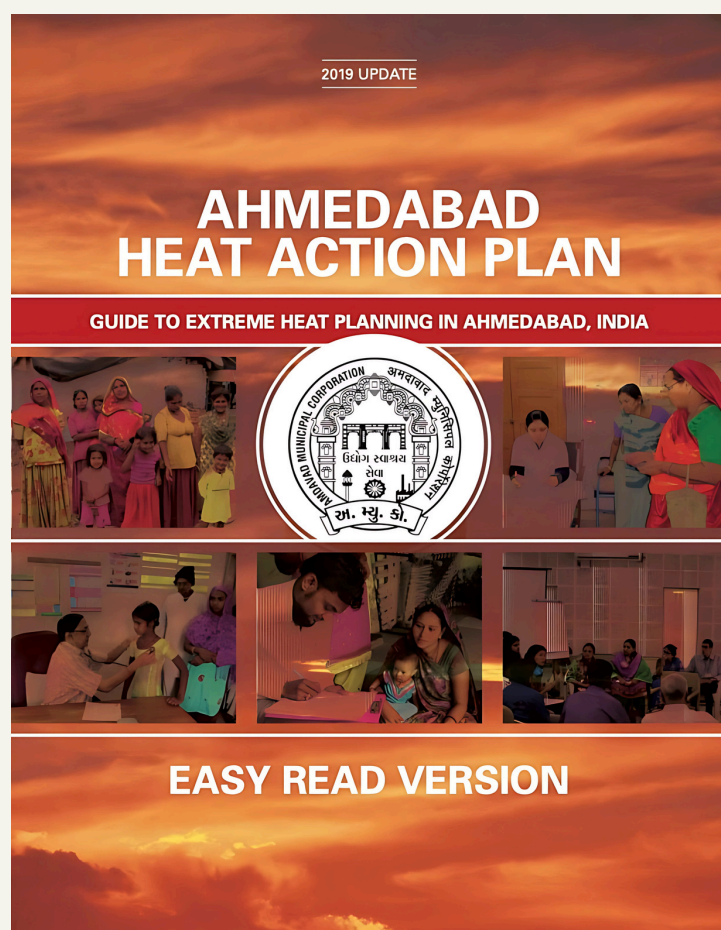
Recommendations

For City Officials

- Set clear standards for designing, constructing, and maintaining green roofs to ensure they work well.
- Encourage collaboration between the Pune Municipal Corporation, private developers, and environmental experts to share knowledge and resources.
- Promote hybrid solar-green roofs to boost energy savings and renewable energy use.
- Provide subsidies or tax incentives to make green roofs more affordable for buildings.
- Make sure there are proper systems in place to prevent leaks and maintain green roof quality.

For Developers and Builders

- Use affordable materials and smart design methods to reduce the cost of installing green roofs.
- Integrate modern technologies like living walls, vertical gardens, and porous materials to make green roofs more attractive and effective.
- Push for green roofs that serve multiple purposes, such as stormwater management, cooling the city, and improving energy efficiency.

For Residents and Individuals

- Educate yourself about the benefits of green roofs through awareness campaigns and community workshops.
- Consider incorporating green roofs or other sustainable practices in your own properties to help reduce environmental impacts.
- Support and participate in creative reuse projects that repurpose existing materials (e.g., old containers or tires) for green roof designs.

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Conclusion

Green Roof Technology holds great promise for addressing the environmental challenges of urbanization in Pune. By improving air quality, reducing energy usage, and creating green spaces, Green roof technology can significantly contribute to more sustainable urban growth. As the city expands, integrating nature into urban areas becomes vital, and green roofs are an effective way to achieve this.

While it's not possible to fully restore the natural environment lost to urbanization, Green roof technology can offer a valuable solution. It helps reduce the urban heat island effect, lowers energy consumption, and provides spaces for relaxation and community interaction, improving overall well-being.

To make the most of green roofs, Pune must tackle challenges such as creating supportive policies, offering incentives, and raising awareness among citizens. With the right steps, Green roof technology can play a crucial role in shaping a more sustainable and green future for the city.

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